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The Relationships among Body Weights and Linear Dimensions in Rabbit Breeds and Crosses

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Abstract: A breeding experiment was conducted to assess the relationships among body weights and linear body measurements in rabbit breeds and crosses. Data on 259 and 215 kits from 73 and 62 litters at 35 and 56 weaning and post- weaning ages respectively were used in the study. The litters representing 8 genotypes evolved from random mating involving 49 does and 13 bucks. The traits measured were body Weights (BWT), Nose to Shoulder Length (NTS), Shoulder to Tail Length (STL), Trunk Length (TKL), heart girth (HGT), height at withers (HTW) and length of ear. Measurements of the body components for each genotype were regressed against live weight at 35 and 56 days of age using linear and non-linear (exponential and polynomial) regression analyses. The relationship between live weight and each of the measurement were also assessed. The regression equations, estimates of parameters and coefficients of determination (R^2) for the fitted functions were determined. Body measurements and weight were generally positive and significant ($p < 0.001$) demonstrating strong inter-relationship among the variables. The coefficient of determination varied from 5.27 to 90.3 and from 0.090 to 90.6 at 35 and 56 days respectively. Based on R^2, polynomial function was superior in terms of goodness of fit to the data and its ability to predict. Body weight was better predicted using STL of genotype NZWDBD x NZWDBD at both ages.

Key words: Rabbits body weight, linear dimensions

INTRODUCTION

The live body weights and linear traits contribute significantly to the lifetime performance of the animal. Studies involving body measurements and weights in poultry[1-4]swine sheep[6,8] goat[9,10] cattle [11-131] have been reported. Findings from these investigations have been used to describe body conformation and carcass composition, to evaluate breed performance and predict live weight gain, to examine relationships among economic characteristics and reproductive performance and to study the interactions between heredity and environment. The associations among live body measurements were established through the examination of correlation among them. Studies of interrelationships among body measurements also find application in selection and breeding. The magnitude of the correlation between live body measurements and raw meat yields was reported to be a valuable indicator for selecting high meat yielding strains of turkeys[18] .

At maturity, linear measurements are essentially reflecting heritable size of the skeleton [11] . According to Searle et al.[6] the skeletal growth and muscular development are interconnected. Skeletal dimensions especially shoulder width, heart girth and height at withers are good indicators of live weight and condition score[10]. In addition, heart girth that reflects the physiological status of animal has also been considered as the best indicator of live weight and condition[5].

The simple linear body measurements that can reliably predict body weight without necessitating animal slaughter will be particularly desirable.Most references in available literature relating linear measurements to production traits in animals have involved studies with cattle, poultry, sheep and goat. Only limited information is available on association among live body measurements in rabbits. This study therefore was designed to determine the existing relationships between body weight and linear body measurements such as Nose to Shoulder Length (NTS) Shoulder to Tail Length (STL) Heart Girth (HGT), Height at withers (HWT), Trunk Length (TKL) and Length of Ear (LTE) at weaning and post-weaning ages in rabbits. It further attempts to predict live body weight from linear measurements using models or indices in the study.

MATERIALS AND METHODS

Location of study: The study was conducted in the rabbit unit of the Teaching and Research Farm of the Federal

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University of Technology,Akure,Nigeria.Akure is situated on 350.52 m above sea level at latitude 7°14'N and at longitude 5°14'E. The city falls within the rainforest zone of the humid tropics which is characterized by hot and humid climate. The mean annual rainfall is 1500 mm and the rains period is bimodal with a short break in August. The mean annual relative humidity is 75% and that of temperature is 20°C.

Animal and their management: 259 and 215 rabbit kits at 35 and 56 days of age from 73 and 61 litters obtained from a cross breeding experiment involving 13 bucks and 49 does were used in the study. The 49 does representing 15 New Zealand white (NZW) and 13 Chinchilla (CHA) purebreds, 11 New Zealand white x Dutch belted (NZWDBD), 10 New Zealand white x Croel (NZWCRL) crossbreds were randomly assigned to 13 bucks (3 NZW and 5 CHA purebreds, and 3 NZWDBD and 2 NZWCRL crossbreds) for mating early in the morning. The litters produced, representing 8 genotypes from the mating were assessed for linear body parameters. The kits were sexed at 21 days. Litters were weaned at 35 days when each kit was individually ear-tagged. Litter mates were kept together in the same cage to post-weaning age of 56 days.

Housing: The rabbits were housed in cages. Each cage or hutch has the following dimensions: length 105 cm, width 85cm and height 60cm. The hutches were raised on wooden or metallic legs about 60cm above the ground.

The rabbits in hutches were placed inside a low walled house built with concrete block and corrugated iron sheets as roofing material. The wooden and metallic hutches were covered to some extent with mesh that would permit inspection, ventilation and dropping of rabbit faeces onto the cemented floor. Kindling boxes (each having the following dimensions: length -40cm, width 30cm and height 25cm with a small hole measuring 15cm by 15cm) were provided inside the cages. Also supplied in each cage were feeding and watering troughs, which were made from tins.

Feeding and watering: The rabbits were given ad libitum access to commercial diet in the morning, supplemented with sweet potato leaves and Aspillia africana in the evening over the course of the experiment. The chemical composition of the commercial diet consisted of 2300 kcal/kg metabolisable energy, 15% crude protein, 8.0% ash, 7.2% fibre, 0.67% ether extract, 8.24% moisture content and 91.76% dry matter. The chemical composition of the sweet potato leaf was 11.68% crude protein, 7.68% ash, 3.22% fibre, 0.72% ether extract, 93.12% moisture content and 6.88% dry matter while that of Aspillia africana was 17.41% crude protein, 12.98% ash, 6.65% fibre, 0.87% ether extract, 93.33% moisture content and 6.67% dry matter. Clean water was supplied regularly.

Sanitation and Health management: The rabbit house and its surroundings were kept clean. Practices such as sweeping and washing of the floor and troughs were done regularly. The incidence of diarrhea was combated with antibiotics such as embassin forte^R. To ensure absence of haemoparasites, internal and external parasites, the animals were treated with IVOMEC^R injection.

Data collection: Basic information of genetic groups, buck and doe were kept on each kit in addition to live weight and linear body measurement records at weaning age of 35 days and post-weaning age of 56 days. The linear traits studied were Nose to Shoulder length (NTS), Shoulder to tail length (STL), Trunk Length (TKL), Heart Girth (HGT) Height at Withers (HTW) and Length of the Ear (LTE). Measurements were taken with the aid of a measuring tape and ruler on the 259 and 215 kits at 35 and 56 days of age respectively. The differences in number of kits at various ages were brought about by mortality recorded during the experiment.
The description of the measurements is as follows:

Head to shoulder length: The distance from the nose to the point of the shoulder

Shoulder to tail length: The distance from the point of shoulder to pin bone or to the end of the occygeal vertebrate.

Trunk length: The longitudinal distance from the point of the shoulder to the tuberosity of the ischium.

Heart girth: Measured as body circumference just behind the fore leg.

Height at withers: Measured on the dorsal midline at the highest point on the withers.

Length of ear: The distance from the base of the attachment of the ear to the head to the tip of the ear.
All the measurements were taken in the morning before feeding the animals. Each animal was gently restrained to hold it in an unforced position while taking measurements.

The body weights and linear measurements taken at 35 and 56 days for genetic groups were collected and used for analysis.
The 8 genetic groups were defined as shown:

New Zealand white x New Zealand white(NZW x NZW) and Chinchilla x Chinchilla (CHA x CHA) purebreds; and New Zealand white x Chinchilla (NZW x CHA),New Zealand white Dutch-belted x New Zealand white Dutch-belted(NZWDBD x NZWDBD), New Zealand white x New Zealand white Dutch-belted(NZW x NZWDBD), New Zealand white Croel x New Zealand white Croel(NZWCRL x NZWCRL),Chinchilla x New Zealand white Dutch-belted(CHA x NZWDBD) and Chinchilla x New Zealand white Croel(CHA x NZWCRL) crossbreds.

ANALYTICAL PROCEDURES

Measurements of each body component, nose to shoulder length (NTS) shoulder to tail length (STL), heart girth (HGT), height at withers (HWT), trunk length (TKL) and length of ear (LTE) were regressed against live body weights at 35 and 56 days of age using both linear and non-linear (exponential, and polynomial) regression analyses (SAS, 1999).

Y = a + bx ------------------(1) (linear)

Y_1 = aie bx ------------------(2) (exponential)

Y_2 = $a_2 + b_2x + (C_2x^2)$ ------(3) (polynomial)

Where, Y, Y_1, Y_2 are dependent variables (live weights, x represents the independent variables (NTS, STL, HGT, HWT, TKL and LTE), and b and c are regression coefficients associated with the independent variables when the independent variable is zero.

Logarithmic transformation was performed on equation (2) to fit the model with the variable data, resulting in the following equation:

$$\text{Log10}Y_1 = \text{Log10}a_1 + bx.$$

Regression equations were determined for each genotype and tested for parallelism. The relationships between live weight and each of the linear measurements were also assessed. The coefficient of determination (R^2) was used to compare the accuracy of prediction.

RESULTS

Weights-linear measurements at 35 days of age: Tables 1-6 present equations, estimates of parameters and coefficients of determination for the fitted functions. Generally, linear body measurements and weight associated significantly ($p < 0.05$ or $p < 0.01$ or $p < 0.001$), demonstrating strong interrelationships between the variables. Using simple linear, exponential and quadratic functions, the value of coefficient of determination (R^2) ranged from 5.27 to 90.3, being maximum for TKL of genotype NZWCRL x NZWCRL in quadratic function (Table 6) and minimum for LTE of genotype NZW x NZW in quadratic function (Table 5). The analyses further revealed that majority of the regression coefficients for body weights on linear measurements were positive.
Besides, few regression coefficients for body weights on linear measurements were negative under quadratic function.

Table1: Estimation of parameters in Simple Linear, Exponention and Quadratic function fiffed for Weights-Linear Measurement (NTS) Relationship at Weaning Age of 35 days

Linear measurement	Genotype	Functions	S.E	R2(%)	Significant
Nose to Shoulder (NTS)	NZW x NZW	Y = 34.40 + 21.15x	2.14	7.8	*
Nose to Shoulder (NTS)	NZW x NZW	Y1 = -284.41e + 230.65x	109.93	7.5	*
Nose to Shoulder (NTS)	NZW x NZW	Y2 = 1001.79 – 153.89x + 7.82x2	9.81	8.9	NS
Nose to Shoulder (NTS)	CHA x CHA	Y = -760.91 + 90.95x	10.74	52.9	* * *
Nose to Shoulder (NTS)	CHA x CHA	Y1 = -2356.15e + 1082.50x	132.51	51.0	* * *
Nose to Shoulder (NTS)	CHA x CHA	Y2 = 3652.00 – 637.73x + 29.93x2	9.31	59.5	* *
Nose to Shoulder (NTS)	NZWDBD x NZWDBD	Y = -828.21 + 92.05x	11.41	75.6	* *
Nose to Shoulder (NTS)	NZWDBD x NZWDBD	Y1 = -2674.66e + 1186.99x	149.9	74.9	* * *
Nose to Shoulder (NTS)	NZWDBD x NZWDBD	Y2 = 3090.58 – 513.21x + 23.31x2	16.86	77.7	NS
Nose to Shoulder (NTS)	NZW x NZWDBD	Y = -501.35 + 66.54x	11.09	67.9	* * *
Nose to Shoulder (NTS)	NZW x NZWDBD	Y1 = -1676.67e + 795.48x	141.54	65.0	* * *
Nose to Shoulder (NTS)	NZW x NZWDBD	Y2 = 2233.33 – 380.25x + 18.15x2	7.02	77.4	*
Nose to Shoulder (NTS)	NZW x CHA	Y = -236.71 + 46.14x	10.27	42.8	* * *
Nose to Shoulder (NTS)	NZW x CHA	Y1 = -1030.76e + 543.20x	120.99	42.7	* * *
Nose to Shoulder (NTS)	NZW x CHA	Y2 = -314.98 + 59.46x – 0.56x2	11.19	42.8	NS
Nose to Shoulder (NTS)	CHA x NZWDBD	Y = -216.57 + 41.75x	5.92	60.8	* * *
Nose to Shoulder (NTS)	CHA x NZWDBD	Y1 = -945.24e + 495.69x	74.96	57.7	* * *
Nose to Shoulder (NTS)	CHA x NZWDBD	Y2 = 1656.45 – 265.32x + 12.50x2	3.71	71.3	* *
Nose to Shoulder (NTS)	CHA x NZWCRL	Y = -264.39 + 47.34x	16	62.0	* *
Nose to Shoulder (NTS)	CHA x NZWCRL	Y1 = -1016.50e + 532.29x	189.11	36.1	*
Nose to Shoulder (NTS)	CHA x NZWCRL	Y2 = 2999.83 + 516.02x + 24.09x2	12.36	52.4	NS
Nose to Shoulder (NTS)	NZWCRL x NZWCRL	Y = -412.87 + 60.97x	25.59	28.8	*
Nose to Shoulder (NTS)	NZWCRL x NZWCRL	Y1 = -1370.84e + 681.71x	304.69	26.3	*
Nose to Shoulder (NTS)	NZWCRL x NZWCRL	Y2 = 7926.47 – 1367.20x + 60.64x2	19.68	58.9	* *

Table2: Estimate of Parameters in Simple Linear, Exponential and Quadratic Functions fitted for Weights-Linear Measurement (STL) Relationships at Weaning Age of 35 days

Linear measurement	Genotype	Function	S.E	R^2(%)	Significant
Shoulder to Tail (STL)	NZW x NZW	$Y = -406.95 + 29.77x$	4.29	47.2	* * *
Shoulder to Tail (STL)	NZW x NZW	$Y_1 = -1806.38e + 665.44x$	101.96	44.1	* * *
Shoulder to Tail (STL)	NZW x NZW	$Y_2 = 1844.28 – 164.18x + 4.15x^2$	1.2	156.8	* * *
Shoulder to Tail (STL)	CHA x CHA	$Y = -574.02 + 38.20x$	3.42	66.2	* * *
Shoulder to Tail (STL)	CHA x CHA	$Y_1 = -2620.21e + 933.54x$	85.89	64.9	* * *
Shoulder to Tail (STL)	CHA x CHA	$Y_2 = 1244.50 – 109.34x + 2.97x^2$	1.35	68.6	*
Shoulder to Tail (STL)	NZWDBD x NZWDBD	$Y = -244.73 + 24.73x$	3.74	67.6	* * *
Shoulder to Tail (STL)	NZWDBD x NZWDBD	$Y_1 = -1603.42e + 614.95x$	95.33	66.5	* * *
Shoulder to Tail (STL)	NZWDBD x NZWDBD	$Y_2 = 1878.66 – 145.20x + 3.37x^2$	2.13	71.2	NS
Shoulder to Tail (STL)	NZW x NZWDBD	$Y = -449.28 + 32.77x$	5.47	67.8	* * *
Shoulder to Tail (STL)	NZW x NZWDBD	$Y_1 = -2014.05e + 740.39x$	132.24	64.8	* * *
Shoulder to Tail (STL)	NZW x NZWDBD	$Y_2 = 1815.16 – 162.74x + 4.19x^2$	1.74	76.4	*
Shoulder to Tail (STL)	NZW x CHA	$Y = -204.38 + 22.20x$	3.40	61.3	* * *
Shoulder to Tail (STL)	NZW x CHA	$Y_1 = -1311.87e + 516.98x$	78.33	61.7	* * *
Shoulder to Tail (STL)	NZW x CHA	$Y_2 = -551.91 + 52.21x – 0.64x^2$	1.31	61.6	NS
Shoulder to Tail (STL)	CHA x NZWDBD	$Y = -178.40 + 20.42x$	3.81	47.2	* * *
Shoulder to Tail (STL)	CHA x NZWDBD	$Y_1 = -1191.86e + 473.46x$	90.40	46.2	* * *
Shoulder to Tail (STL)	CHA x NZWDBD	$Y_2 = 758.20 – 59.40x + 1.69x^2$	1.57	49.1	NS
Shoulder to Tail (STL)	CHA x NZWCRL	$Y = -623.08 + 39.05x$	7.71	64.7	* * *
Shoulder to Tail (STL)	CHA x NZWCRL	$Y_1 = -2660.19e + 936.44x$	187.17	64.1	* * *
Shoulder to Tail (STL)	CHA x NZWCRL	$Y_2 = 747.47 + 74.77x + 2.35x^2$	4.67	65.4	NS
Shoulder to Tail (STL)	NZWCRL x NZWCRL	$Y = -638.29 + 40.67x$	4.45	85.6	* * *
Shoulder to Tail (STL)	NZWCRL x NZWCRL	$Y_1 = -2746.72e + 971.50x$	112.54	84.2	* * *
Shoulder to Tail (STL)	NZWCRL x NZWCRL	$Y_2 = 2595.77 – 228.25x + 5.56x^2$	2.27	90.2	*

Table3: Etimation of parameters in Simple Linear, Exponential and Quadratic Functions fitted for Weights-Linear Measurement (NTS) Relationship at Weaning Age of 35 days

Linear measurement	Genotype	Function	S.E	R^2%)	Significant
Heart to girth	(HGT)NZW x NZW	$Y = -359.47+39.17x$	8.47	28.4	* * *
Heart to girth	(HGT)NZW x NZW	$Y_1 = -1806.38e + 665.44x$	101.96	44.1	* * *
Heart to girth	(HGT)NZW x NZW	$Y_2 = 3280.91 – 409.32x + 13.75x^2$	4.35	39.7	* * *
Heart to girth	(HGT)CHA x CHA	$Y = -429.77 + 47.38x$	6.73	43.6	* * *
Heart to girth	(HGT)CHA x CHA	$Y_1 = -2620.22e + 933.54x$	85.89	64.9	* * *
Heart to girth	(HGT)CHA x CHA	$Y_2 = 526.47 – 68.15x + 3.43x^2$	3.70	44.4	NS
Heart to girth	(HGT)NZWDBD x NZWDBD	$Y = -338.49 + 40.49x$	3.69	85.2	* * *
Heart to girth	(HGT)NZWDBD x NZWDBD	$Y_1 = -1603.42e + 614.95x$	95.33	66.5	* * *
Heart to girth	(HGT)NZWDBD x NZWDBD	$Y_2 = -386.44 + 45.89x + 0.15x^2$	1.84	85.2	NS
Heart to girth	(HGT)NZW x NZWDBD	$Y = -232.26 + 32.55x$	4.82	72.8	* * *
Heart to girth	(HGT)NZW x NZWDBD	$Y_1 = -2014.05e + 740.39x$	132.24	64.8	* * *
Heart to girth	(HGT)NZW x NZWDBD	$Y_2 = 1252.16 – 143.46x + 5.15x^2$	2.00	80.8	*
Heart to girth	(HGT)NZW x CHA	$Y = -114.19 + 26.64x$	6.57	37.6	* * *
Heart to girth	(HGT)NZW x CHA	$Y_1 = -1311.87e + 516.98x$	78.33	61.7	* * *
Heart to girth	(HGT)NZW x CHA	$Y_2 = -2359.71 + 300.95x – 8.30x^2$	3.06	51.6	*
Heart to girth	(HGT)CHA x NZWDBD	$Y = 54.85 + 15.23x$	6.01	16.7	*
Heart to girth	(HGT)CHA x NZWDBD	$Y_1 = -1191.86e + 473.46x$	90.40	46.2	* * *
Heart to girth	(HGT)CHA x NZWDBD	$Y_2 = -2661.49 + 352.14x - 10.35x^2$	3.89	32.2	*
Heart to girth	(HGT)CHA x NZWCRL	$Y = 117.28 + 11.99x$	16.50	3.6	NS
Heart to girth	(HGT)CHA x NZWCRL	$Y_1 = 2660.19e + 936.44x$	187.17	64.1	* * *
Heart to girth	(HGT)CHA x NZWCRL	$Y_2 = -12036.13 + 1501.03x + 45.38x^2$	13.60	48.1	* *
Heart to girth	(HGT)NZWCRL x NZWCRL	$Y = -404.72 + 43.59x$	10.70	54.2	* * *
Heart to girth	(HGT)NZWCRL x NZWCRL	$Y_1 = -2746.73e + 971.50x$	112.54	84.2	* * *
Heart to girth	(HGT)NZWCRL x NZWCRL	$Y_2 = -4978.51 – 575.44x + 15.37x^2$	9.72	61.6	NS

A comparison on the basis of R^2 values showed that the weaning weights and linear measurements of the genotypes were fitted best by the quadratic function, followed by regression and exponential. The 3 models in some cases, gave poor fit to the relationships between live body weight and linear measurements.

Generally, inferior fit or poor R^2 values were obtained for the three functions to some weight-linear measurements. But exponential function having high standard error of prediction might be considered worse than the other three models.

Among the body measurements, accuracy of prediction was better with NTS (R^2 – 75, 74 and 77 in(Table 1); HGT (R^2 – 85.2, 66.5, 85.2 (Table 3); HWT (R^2 – 78.8, 78.0, 80.0 in (Table 4) genotype NZWDBD x NZWDBD; and STL (R^2 – 85.6, 84.2, 90.2 (Table 2) and TKL (R^2 – 83.4, 81.9, 90.3 in (Table 6) in genotype NZWCRL x NZWCRL.

Weights-linear measurements at 56 days of age: Tables 7 to 12 show equations, estimates of parameters and coefficients of determination for the fitted functions

Table 4: Estimates of Parameters in Simple Linear, Exponential and Quadratic Functions Fitted for Weight-Linear Measurement (HWT) Relationship at Weaning Age of 35 Days

Linear measurement	Genotype	Function	S.E	R^2%	Significant
Height at Withers (HWT)	NZW x NZW	$Y = -52.65 + 37.21x$	10.44	19.1	* * *
Height at Withers (HWT)	NZW x NZW	$Y_1 = -431.49e + 325.72x$	92.86	18.1	* * *
Height at Withers (HWT)	NZW x NZW	$Y_2 = 597.12 – 109.49x + 8.18x^2$	9.93	20.1	NS
Height at Withers (HWT)	CHA x CHA	$Y = -204.13 + 61.23x$	10.23	35.9	* * *
Height at Withers (HWT)	CHA x CHA	$Y_1 = -826.64e + 536.05x$	90.45	35.4	* * *
Height at Withers (HWT)	CHA x CHA	$Y_2 = 135.61 – 16.10x + 4.33x^2$	9.45	36.1	NS
Height at Withers (HWT)	NZWDBD x NZWDBD	$Y = 468.48 + 86.52x$	9.81	78.8	* * *
Height at Withers (HWT)	NZWDBD x NZWDBD	$Y_1 = -1511.65e + 829.40x$	96.22	78.0	* * *
Height at Withers (HWT)	NZWDBD x NZWDBD	$Y_2 = 985.69 - 215.69x + 15.62x^2$	14.18	80.0	NS
Height at Withers (HWT)	NZW x NZWDBD	$Y = 91.60 + 27.15x$	13.42	19.4	NS
Height at Withers (HWT)	NZW x NZWDBD	$Y_1 = -170.89e + 231.52x$	116.95	18.7	NS
Height at Withers (HWT)	NZW x NZWDBD	$Y_2 = 860.01 – 151.18x + 10.15x^2$	14.45	21.8	NS
Height at Withers (HWT)	NZW x CHA	$Y = -116.36 + 48.16x$	12.56	35.3	* * *
Height at Withers (HWT)	NZW x CHA	$Y_1 = -643.82e + 438.20x$	112.03	36.2	* * *
Height at Withers (HWT)	NZW x CHA	$Y_2 = -1006.98 + 246.43x – 10.94x^2$	13.00	37.0	NS
Height at Withers (HWT)	CHA x NZWDBD	$Y = -42.16 + 37.94x$	10.02	30.9	* *
Height at Withers (HWT)	CHA x NZWDBD	$Y_1 = -356.45e + 298.86x$	88.43	26.3	* *
Height at Withers (HWT)	CHA x NZWDBD	$Y_2 = 2143.74 - 471.60x + 29.41x^2$	5.85	62.0	* * *
Height at Withers (HWT)	CHA x NZWCRL	$Y = -399.87 + 75.52x$	30.39	30.6	*
Height at Withers (HWT)	CHA x NZWCRL	$Y_1 = -1242.93e + 693.61x$	287.63	30.2	*
Height at Withers (HWT)	CHA x NZWCRL	$Y_2 = 1383.79 + 310.59x + 20.82x^2$	51.28	31.5	NS
Height at Withers (HWT)	NZWCRL x NZWCRL	$Y = -531.25 + 93.12x$	21.28	57.8	* * *
Height at Withers (HWT)	NZWCRL x NZWCRL	$Y_1 = -1608.44e + 872.35x$	204.06	56.6	* * *
Height at Withers (HWT)	NZWCRL x NZWCRL	$Y_2 = 4040.66 – 874.57x + 50.96x^2$	35.72	63.5	NS

Table 5: Estimate of Parameters in Simple Linear, Exponential and Quadratic Functions Fitted for Weight-Linear Measurement (LTE) Relationship at Weaning Age of 35 Days

Linear measurement	Genotype	Function	S.E	R2(%)	Significant
Length of Ear (LTE)	NZW x NZW	Y = -21.80 + 36.50x	8.46	25.6	* * *
Length of Ear (LTE)	NZW x NZW	Y1 = -308.98e + 280.22x	68.1	23.9	* * *
Length of Ear (LTE)	NZW x NZW	Y2 = 462.29 – 84.58x + 7.42x2	5.27	5.27	NS
Length of Ear (LTE)	CHA x CHA	Y = -28.87 + 43.74x	10.16	22.5	* * *
Length of Ear (LTE)	CHA x CHA	Y1 = -441.89e + 368.59x	85.21	22.6	* * *
Length of Ear (LTE)	CHA x CHA	Y2 = -237.89 + 93.39x - 2.89x2	6.7	6.7	NS
Length of Ear (LTE)	NZWDBD x NZWDBD	Y = -404.45 + 79.68x	12.87	64.6	* * *
Length of Ear (LTE)	NZWDBD x NZWDBD	Y1 = -1352.34e + 758.20x	124.26	63.9	* * *
Length of Ear (LTE)	NZWDBD x NZWDBD	Y2 = 2283.03 - 483.47x + 29.35x2	25.13	25.13	NS
Length of Ear (LTE)	NZW x NZWDBD	Y = 107.86 + 25.79x	14.24	16.2	NS
Length of Ear (LTE)	NZW x NZWDBD	Y1 = -128.26e + 213.66x	122.13	15.3	NS
Length of Ear (LTE)	NZW x NZWDBD	Y2 = 1421.10 – 284.31x + 17.98x2	16.05	16.05	NS
Length of Ear (LTE)	NZW x CHA	Y = -62.86 + 42.61x	13.76	26.2	* *
Length of Ear (LTE)	NZW x CHA	Y1 = -524.92e + 385.54x	125.79	25.8	* *
Length of Ear (LTE)	NZW x CHA	Y2 =416.47 - 62.58x + 5.72x2	13.77	13.77	NS
Length of Ear (LTE)	CHA x NZWDBD	Y = -152.61 + 50.24x	9.92	44.5	* * *
Length of Ear (LTE)	CHA x NZWDBD	Y1 = -659.47e + 437.11x	90.69	42.1	* * *
Length of Ear (LTE)	CHA x NZWDBD	Y2 = 1548.97 - 329.40x + 21.03x2	8.86	8.86	*
Length of Ear (LTE)	CHA x NZWCRL	Y = -357.85 + 71.49x	26.64	34.0	*
Length of Ear (LTE)	CHA x NZWCRL	Y1 = -1221.15e + 685.82x	253.54	34.3	*
Length of Ear (LTE)	CHA x NZWCRL	Y2 = -2471.94 + 515.05x - 23.17x2	46.43	46.43	NS
Length of Ear (LTE)	NZWCRL x NZWCRL	Y = -628.97 + 106.26x	20.1	66.6	* * *
Length of Ear (LTE)	NZWCRL x NZWCRL	Y1 = -1890.05e + 1009.64x	190.74	66.7	* * *
Length of Ear (LTE)	NZWCRL x NZWCRL	Y2 = -975.88 + 179.36x - 3.83x2	28.44	28.44	NS

namely simple linear, exponential and quadratic functions. While some post-weaning linear body measurements and post-weaning weights had significant ($p < 0.05$, $p < 0.01$, $p < 0.001$) and strong inter-relationships between them, others were not significant ($P > 0.05$). At post-weaning age of 56 days, the coefficient of determination (R^2) from the models varied from 0.090 to 90.6. The R^2 obtained by using linear, exponential and polynomial functions ranged from 0.9 - 90.6, 1.0 - 89.8 and 4.5 - 90.6 respectively. The regression coefficients for body weights on linear measurements were either positive or negative.

On the basis of R^2, body weights-linear measurement relationships were fitted best by quadratic, followed by linear and exponential functions. There was either good or poor fit obtained for the any of the three models to weight- linear measurements of various genotypes. There were very poor fit for the functions to weight – WTH of

Table 6: Estimate of Parameters in Simple Linear, Exponential and Quadratic Functions Fitted for Weight-Linear Measurement (TKL) Relationship at Weaning Age of 35 Days

Linear measurement	Genotype	Function	S.E	R2(%)	Significant
Trunk length (TKL)	NZW x NZW	Y = -241.90 + 29.10x	5.52	34.0	* * *
Trunk length (TKL)	NZW x NZW	Y1 = -1194.57e + 511.56x	102.04	31.8	* * *
Trunk length (TKL)	NZW x NZW	Y2 = 1515.13 – 163.43x + 5.23x2	1.99	41.6	*
Trunk length (TKL)	CHA x CHA	Y = -421.17 + 40.67x	4.95	51.3	* * *
Trunk length (TKL)	CHA x CHA	Y1 = -1921.83e + 773.35x	95.06	50.8	* * *
Trunk length (TKL)	CHA x CHA	Y2 = -62.54 + 3.11x + 0.99x2	2.25	51.4	NS
Trunk length (TKL)	NZWDBD x NZWDBD	Y = -236.09 + 30.68x	5.25	61.9	* * *
Trunk length (TKL)	NZWDBD x NZWDBD	Y1 = -1440.59e + 607.67x	107.14	60.5	* * *
Trunk length (TKL)	NZWDBD x NZWDBD	Y2 = 3237.83 - 317.29x + 8.64x2	3.88	69.5	*
Trunk length (TKL)	NZW x NZWDBD	Y = -415.04 + 39.28x	6.68	67.0	*
Trunk length (TKL)	NZW x NZWDBD	Y1 = -1775.08e + 716.16x	129.47	64.3	* * *
Trunk length (TKL)	NZW x NZWDBD	Y2 = 1560.94 – 172.51x + 5.64x2	2.69	74.1	NS
Trunk length (TKL)	NZW x CHA	Y = -228.49 + 29.05x	4.17	64.2	* * *
Trunk length (TKL)	NZW x CHA	Y1 = -1242.59e + 532.85x	76.37	64.3	* * *
Trunk length (TKL)	NZW x CHA	Y2 =-328.58 + 39.99x - 0.30x2	2.03	64.3	NS
Trunk length (TKL)	CHA x NZWDBD	Y = -123.80 + 22.48x	4.51	43.7	* * *
Trunk length (TKL)	CHA x NZWDBD	Y1 = -926.20e + 418.11x	85.48	42.8	* * *
Trunk length (TKL)	CHA x NZWDBD	Y2 = 639.66 - 58.74x + 2.14x2	2.33	45.2	NS
Trunk length (TKL)	CHA x NZWCRL	Y = -580.50 + 46.59x	7.96	71.0	* * *
Trunk length (TKL)	CHA x NZWCRL	Y1 = -2362.66e + 906.58x	155.1	70.9	* * *
Trunk length (TKL)	CHA x NZWCRL	Y2 = -811.38 + 70.33x – 0.61x2	5.92	71.0	NS
Trunk length (TKL)	NZWCRL x NZWCRL	Y = -668.85 + 52.43x	6.24	83.4	* * *
Trunk length (TKL)	NZWCRL x NZWCRL	Y1 = -2597.93e + 994.52x	125.14	81.9	* * *
Trunk length (TKL)	NZWCRL x NZWCRL	Y2 = 3780.41 + 413.06x + 12.11x2	3.99	90.3	* *

Table 7: Estimate of Parameters in Simple Linear, Exponential and Quadratic Functions Fitted for Weights-Linear Measurement (NTS) Relationship at Post-Weaning Age of 56 Days

Linear measurement	Genotype	Functions	S.E	R^2%	Significant
Nose to Shoulder (NTS)	NZW x NZW	$Y = -761.95 + 90.41x$	12.32	52.9	* * *
	NZW x NZW	$Y_1 = -2717.64\ e + 1221.65x$	171.24	51.5	* * *
-	NZW x NZW	$Y_2 = 3524.56 – 535.53x + 22.74x^2$	10.02	57.5	*
-	CHA x CHA	$Y = -503.99 + 72.19x$	15.39	27.2	* * *
-	CHA x CHA	$Y_1 = -2107.35\ e + 991.46x$	221.69	25.3	* * *
-	CHA x CHA	$Y_2 = 8482.39 – 190.41x + 44.17x^2$	11.19	42.6	* * *
-	NZWDBDxNZWDBD	$Y = -990.27 + 107.39x$	15.96	68.3	* * *
-	NZWDBDx NZWDBD	$Y_1 = -3631.00\ e + 1571.99x$	234.84	68.1	* * *
-	NZWDBDx NZWDBD	$Y_2 = -323.30 + 16.14x + 3.10x^2$	16.70	68.4	NS
-	NZW x NZWDBD	$Y = -308.67 + 55.98x$	11.57	57.9	* * *
-	NZW x NZWDBD	$Y_1 = -1537.57e + 763.87x$	167.04	55.2	* * *
-	NZW x NZWDBD	$Y_2 = 2565.55 – 354.45x + 14.55x^2$	6.53	67.9	*
-	NZW x CHA	$Y = 451.94 + 3.82x$	32.61	1.0	NS
-	NZW x CHA	Y1 = 384.98e + 45.82x	477.29	1.0	NS
-	NZW x CHA	$Y_2 = 7421.57 – 948.29x + 32.47x^2$	42.21	5.7	NS
-	CHA x NZWDBD	$Y = -172.39 + 41.69x$	8.73	53.3	* * *
-	CHA x NZWDBD	$Y_1 = -989.11\ e + 531.51x$	119.88	49.6	* * *
-	CHA x NZWDBD	$Y_2 = 2788.72 – 407.29x + 16.81x^2$	4.59	72.6	* *
-	CHA x NZWCRL	$Y = 163.15 + 19.11x$	15.30	12.4	NS
-	CHA x NZWCRL	$Y_1 = -253.41e + 259.35x$	212.60	11.9	NS
-	CHA x NZWCRL	$Y_2 = 5309.58 – 724.16x + 26.78x^2$	24.27	21.9	NS
-	NZWCRLxNZWCRL	$Y = -272.58 + 55.77x$	39.70	14.1	NS
-	NZWCRL x NZWCRL	$Y_1 = -1604.99e + 800.97x$	572.82	14.0	NS
	NZWCRL x NZWCRL	$Y = 3446.34 – 460.03x + 17.87x^2$	74.65	14.6	NS

NZW x CHA and CHA x NZWCRL, weight - LTE of NZW x CHA, CHA x CHA and CHA x NZWCRL; and weight-TKL of CHA x NZWCRL (Tables 10, 11and 12).

Among the body measurements, accuracy of prediction was better with NTS (R^2 68.3, 68.1, 68.4 in Table 7); STL (R^2 = 89.3, 88.6, 90.6 in Table 8); HGT (R^2 = 80.2, 80.8, 81.0 in Table 9; WTH (R^2 = 82.8, 82.4, 82.9 in Table 10); LTE (R^2 = 90.6, 89.8, 90.2 in Table 11) and TKL (R^2 = 90.1, 89.5, 90.4 in Table 12) of genotype NZWDBD x NZWDBD.

DISCUSSION

The results of the study clearly showed that the simple linear, exponential or quadratic functions could be used in describing the weight-linear measurement relationships in rabbit. At 35 days of age, simple quadratic model had theoretical advantage over linear and exponential functions in respect to its goodness of fit to the data. At 56 days, simple polynomial function also performed better in its descriptive capacity compared to

Table 8: Estimate of Parameters in Simple Linear, Exponential and Quadratic Functions Fitted for Wight-Linear Measurement (STL) Relationship at Post-Weaning Age of 56 Days

Linear measurement	Genotype	Function	S.E	R^2%	Significant
Shoulder to tail (STL)	NZW x NZW	$Y = -795.26 + 45.37x$	4.65	66.5	* * *
-	NZW x NZW	$Y_1 = -3881.64e + 1308.56x$	134.13	66.5	* * *
-	NZW x NZW	$Y_2 = -1233.83 + 75.80x - 0.52x^2$	1.69	66.6	NS
-	CHA x CHA	$Y = -472.41 + 34.59x$	4.70	47.9	* * *
-	CHA x CHA	$Y_1 = -2571.26e + 992.10x$	136.58	43.6	* * *
-	CHA x CHA	$Y_2 = 2673.21 - 189.07x + 34.94x^2$	0.98	59.3	* * *
-	NZWDBD x NZWDBD	$Y = -998.42 + 54.23x$	3.98	89.8	* * *
-	NZWDBD x NZWDBD	$Y_1 = -4439.42e + 1490.70x$	116.81	88.6	* * *
-	NZWDBD x NZWDBD	$Y_2 = 590.85 - 60.84x + 2.06x^2$	1.37	90.6	NS
-	NZW x NZWDBD	$Y = -673.46 + 40.91x$	9.31	53.2	* * *
-	NZW x NZWDBD	$Y_1 = -3369.38e + 1153.35x$	267.84	52.2	* * *
-	NZW x NZWDBD	$Y_2 = -4623.32 – 331.28x + 6.52x^2$	4.98	57.7	NS
-	NZW x CHA	$Y = -697.20 + 41.19x$	10.98	56.1	* *
-	NZW x CHA	$Y_1 = -3546.08e + 1201.02x$	318.40	56.4	* *
-	NZW x CHA	$Y_2 =-462.55 + 311.13x - 4.64x^2$	4.47	56.4	* *
-	CHA x NZWDBD	$Y = -499.13 + 33.10x$	2.89	57.1	NS
-	CHA x NZWDBD	$Y_1 = -2588.92e + 906.12x$	80.40	86.4	* * *
-	CHA x NZWDBD	$Y_2 = -282.29 - 17.31x + 0.29x^2$	1.05	86.4	NS
-	CHA x NZWCRL	$Y = 193.55 + 8.69x$	8.89	8.0	NS
-	CHA x NZWCRL	$Y_1 = -366.55e + 241.16x$	244.31	8.1	NS
-	CHA x NZWCRL	$Y_2 = -3392.45 + 269.55x - 4.74x^2$	9.54	10.2	NS
-	NZWCRL x NZWCRL	$Y = -482.67 + 35.27x$	7.62	64.1	* * *
-	NZWCRL x NZWCRL	$Y_1 = -2919.27e + 1027.93x$	218.71	64.8	* * *
-	NZWCRL x NZWCRL	$Y_2 = 3787.49 + 263.49x + 3.93x^2$	4.28	66.6	NS

Table 9: Estimate of Parameters in Simple Linear, Exponential and Quadratic Functions Fitted for Weight-Linear Measurement (HGT) Relationship at Post-Weaning Age of 56 Days

Linear measurement	Genotype	Function	S.E	R^2%	Significant
Heart to girth (HGT)	NZW x NZW	$Y = -990.51 + 77.51x$	11.74	47.6	* * *
-	NZW x NZW	$Y_1 = -3659.35e + 1407.35x$	223.90	45.1	* * *
-	NZW x NZW	$Y_2 = 6317.26 - 704.50x + 20.85x^2$	5.64	59.4	* * *
-	CHA x CHA	$Y = -666.58 + 63.37x$	6.65	60.6	* * *
-	CHA x CHA	$Y_1 = -2984.76e + 1197.59x$	125.78	60.6	* * *
-	CHA x CHA	$Y_2 = -914.80 + 89.62x - 0.69x^2$	3.31	60.0	NS
-	NZWDBD x NZWDBD	$Y = -599.17 + 60.21x$	6.53	80.2	* * *
-	NZWDBD x NZWDBD	$Y_1 = -2792.29e + 1136.33x$	120.71	80.8	* * *
-	NZWDBD x NZWDBD	$Y_2 = -1476.47 + 153.82x - 2.46x^2$	2.73	81.0	NS
-	NZW x NZWDBD	$Y = -254.02 + 38.96x$	8.82	53.4	* * *
-	NZW x NZWDBD	$Y_1 = -1622.70e + 717.17x$	168.57	51.6	* * *
-	NZW x NZWDBD	$Y_2 = 3270.85 – 337.77x + 9.99x^2$	5.06	62.6	NS
-	NZW x CHA	$Y = -22.45 + 28.55x$	13.54	28.8	NS
-	NZW x CHA	$Y_1 = -1052.99e + 534.54x$	253.89	28.7	NS
-	NZW x CHA	$Y_2 =531.88 - 30.72x + 1.58x^2$	21.01	28.8	NS
-	CHA x NZWDBD	$Y = -338.16 + 41.62x$	6.31	68.5	* * *
-	CHA x NZWDBD	$Y_1 = -1730.13e + 741.75x$	111.69	68.8	* * *
-	CHA x NZWDBD	$Y_2 = -858.54 + 100.26x - 1.64x^2$	4.370	68.70	NS
-	CHA x NZWCRL	$Y = 384.23 + 2.84x$	8.77	0.90	NS
-	CHA x NZWCRL	$Y_1 = 267.64e + 58.09x$	156.50	1.20	NS
-	CHA x NZWCRL	$Y_2 = -4555.02 + 555.93x - 15.43x^2$	8.23	26.70	NS
-	NZWCRL x NZWCRL	$Y = -394.69 + 47.27x$	8.74	70.9	* * *
-	NZWCRL x NZWCRL	$Y_1 = -2204.64e + 920.31x$	169.32	71.1	* * *
-	NZWCRL x NZWCRL	$Y_2 = -1427.53 + 153.68x - 2.73x^2$	8.11	71.20	NS

may not necessary be best in all circumstances or with all data. The properties of the model and the data should be examined and the appropriate model chosen[20].

Variations in the function best describing live body weight and body measurement relationship in this study could be associated with differences in the maturing patterns of the different body parts. Russell,[21] observedin cattle that shoulder width attained 35% of its finalmature size at birth, while body length and heart girth were about 39.9% and 35% matured at birth respectively.

The regression coefficient associated with independent variables x and partially representing the amount of change in Y for each unit change in x had a positive value in the relationship between the live weight and some linear measurements. This showed that these parameterswere directly influenced by changes in body weight. Therefore, the observation of positive values for regression coefficient could indicate that live weight gain increases with increase in body dimensions (NTS, STL, HGT, HWT, LTE, and TKL). That is any increase in

Table 10: Estimate of Parameters in Simple Linear, Exponential and Quadratic Functions for Weight-Linear Measurement (HWT) Relationship at Post-Weaning Age of 56 Days

Linear measurement	Genotype	Function	S.E	R^2%	Significant
Height at Withers (HWT)	NZW x NZW	$Y = 298.17 + 16.04x$	8.24	7.30	NS
-	NZW x NZW	$Y_1 = -261.87e + 305.93x$	113.40	13.2	* *
-	NZW x NZW	$Y_2 = -2106.06 + 360.85x – 11.50x^2$	1.57	56.8	* * *
-	CHA x CHA	$Y = -246.87 + 71.27x$	14.91	27.9	* * *
-	CHA x CHA	$Y_1 = -1301.47e + 767.85x$	160.34	28.0	* * *
-	CHA x CHA	$Y_2 = -693.33 + 154.24x - 3.83x^2$	13.48	28.0	NS
-	NZWDBD x NZWDBD	$Y = -739.14 + 110.41x$	10.97	82.8	* * *
-	NZWDBD x NZWDBD	$Y_1 = -2503.67e + 1245.79x$	125.79	82.4	* * *
-	NZWDBD x NZWDBD	$Y_2 = -286.72 + 30.10x + 3.52x^2$	9.84	82.9	NS
-	NZW x NZWDBD	$Y = -49.28 + 48.73x$	16.71	33.2	* *
-	NZW x NZWDBD	$Y_1 = -810.07e + 541.67x$	186.74	33.1	* *
-	NZW x NZWDBD	$Y_2 = 589.88 – 66.50x + 5.16x^2$	24.96	33.4	NS
-	NZW x CHA	$Y = 768.33 - 22.53x$	48.48	1.90	NS
-	NZW x CHA	$Y_1 = 1157.41e - 265.43x$	558.21	2.0	NS
-	NZW x CHA	$Y_2 =14617.25 - 2427.79x + 104.33x^2$	147.13	6.6	NS
-	CHA x NZWDBD	$Y = -321.57 + 68.25x$	9.05	74.0	* * *
-	CHA x NZWDBD	$Y_1 = -1277.18e + 712.56x$	96.75	73.1	* * *
-	CHA x NZWDBD	$Y_2 = 518.21 - 91.86x + 7.57x^2$	8.96	74.9	NS
-	CHA x NZWCRL	$Y = 157.45 + 25.57x$	23.47	74.70	NS
-	CHA x NZWCRL	$Y_1 = -223.14e + 276.06x$	252.09	9.80	NS
-	CHA x NZWCRL	$Y_2 = -970.72 + 235.47x - 9.75x^2$	49.02	10.1	NS
-	NZWCRL x NZWCRL	$Y = -20.36 + 48.61x$	12.84	54.4	* *
-	NZWCRL x NZWCRL	$Y_1 = -952.33e + 611.86x$	148.87	58.5	* *
-	NZWCRL x NZWCRL	$Y_2 = -3772.78 + 669.01x - 25.29x^2$	6.72	80.1	* *

Table 11: Estimate of Parameters in Simple Linear, Exponential and Quadratic Functions for Weight-Linear Measurement (LTE) Relationship at Post-Weaning Age of 56 Days

C	Genotype	Function	S.E	R^2%	Significant
Length of ear (LTE)	NZW x NZW	$Y = -703.41 + 100.74x$	10.60	69.4	* * *
-	NZW x NZW	$Y_1 = -2285.88e + 1169.34x$	115.49	68.1	* * *
-	NZW x NZW	$Y_2 = 1079.92 - 223.63x + 15.56x^2$	9.35	69.9	NS
-	CHA x CHA	$Y = -39.45 + 53.49x$	14.28	19.2	* * *
-	CHA x CHA	$Y_1 = -763.28e + 547.83x$	148.70	18.7	* * *
-	CHA x CHA	$Y_2 = 721.80 - 93.13x + 6.99x^2$	11.42	17.0	NS
-	NZWDBD x NZWDBD	$Y = -976.99 + 133.53x$	9.36	90.6	* * *
-	NZWDBD x NZWDBD	$Y_1 = -3051.26e + 1480.89x$	109.13	89.8	* * *
-	NZWDBD x NZWDBD	$Y_2 = 24.38 - 46.58x + 8.02x^2$	8.36	90.2	NS
-	NZW x NZWDBD	$Y = 132.19 + 33.10x$	15.49	21.2	*
-	NZW x NZWDBD	$Y_1 = -385.45e + 368.54x$	168.90	21.9	*
-	NZW x NZWDBD	$Y_2 = -3647.99 + 727.27x - 31.52x^2$	23.99	28.9	NS
-	NZW x CHA	$Y = 944.76 - 38.28x$	57.16	3.9	NS
-	NZW x CHA	$Y_1 = 1567.40e - 435.23x$	645.75	4.0	NS
-	NZW x CHA	$Y_2 =6172.74 - 963.59x + 40.91x^2$	164.56	4.5	NS
-	CHA x NZWDBD	$Y = -423.26 + 78.65x$	11.67	69.4	* * *
-	CHA x NZWDBD	$Y_1 = -1549.38e + 831.20x$	123.42	69.4	* * *
-	CHA x NZWDBD	$Y_2 = -512.39 + 95.52x - 0.79x^2$	12.74	69.4	NS
-	CHA x NZWCRL	$Y = 166.24 + 25.26x$	22.71	10.1	NS
-	CHA x NZWCRL	$Y_1 = -207.13e + 271.64x$	240.16	10.4	NS
-	CHA x NZWCRL	$Y_2 = -5952.22 + 1180.59x - 54.47x^2$	59.47	17.1	NS
-	NZWCRL x NZWCRL	$Y = -472.39 + 94.66x$	38.34	33.7	*
-	NZWCRL x NZWCRL	$Y_1 = -1906.50e + 1032.86x$	404.90	35.2	*
-	NZWCRL x NZWCRL	$Y_2 = -36421.41+ 6830.79x - 314.98x^2$	49.31	85.9	* * *

bodyweight was as a result of an increase in the linear measurements. Similar positive relationships between live weight and body dimensions had been reported in sheep [6] goat [22] cattle[23,24] poultry[4,20,25,26] and rabbit[14,15] . On the other hand, few regression coefficients in the relationship between live weights and some linear measurements were negative. Reporting negative coefficients for regression values, Dilwali[27] concluded that growth rate decreased with increase in age.

From a practical view point, the importance ofmathematical modeling is for characterization and extrapolation of persistency of production traits and their usefulness will depend on the goodness of fit of models to the data[28] . The choice of models is oftendifficult; especially when the purpose it serves is not clearly defined. In this regard, the descriptive ability of the models is an important consideration for ranking the usefulness of the models[20]. McMillan, *et al*;[29] considered

Table12: Estimate of Parameters in Simple Linear, Exponential and Quadratic Functions for Weight-Linear Measurement (TKL) Relationship at Post-Weaning Age of 56 Days.

Linear Measurement	Genotype	Function	S.E	R^2%	Significant
Trunk length (TKL)	NZW x NZW	$Y = -906.73 + 64.22x$	6.21	69.0	* * *
-	NZW x NZW	$Y_1 = -3845.69e + 1409.06x$	139.85	67.9	* * *
-	NZW x NZW	$Y_2 = 602.96 - 72.08x + 3.06x^2$	2.57	69.9	NS
-	CHA x CHA	$Y = -742.60 + 56.56x$	7.39	49.8	* * *
-	CHA x CHA	$Y_1 = -3478.96e + 1288.65x$	166.11	50.5	* * *
-	CHA x CHA	$Y_2 = -3064.77 + 261.61x - 4.50x^2$	3.28	51.4	NS
-	NZWDBD x NZWDBD	$Y = -1191.06 + 78.49x$	5.67	90.1	* * *
-	NZWDBD x NZWDBD	$Y_1 = -4711.59e + 1699.76x$	127.28	89.5	* * *
-	NZWDBD x NZWDBD	$Y_2 = -271.84 - 6.18x + 1.94x^2$	2.79	90.4	NS
-	NZW x NZWDBD	$Y = -922.38 + 63.98x$	12.25	61.6	* * *
-	NZW x NZWDBD	$Y_1 = -3872.16e + 1410.17x$	274.56	60.8	* * *
-	NZW x NZWDBD	$Y_2 = 4824.63 - 454.19x + 11.66x^2$	9.84	64.7	NS
-	NZW x CHA	$Y = -734.19 + 54.13x$	11.06	68.5	* * *
-	NZW x CHA	$Y_1 = -3346.75e + 1230.62x$	245.64	69.2	* * *
-	NZW x CHA	$Y_2 =-6537.92 + 567.23x - 11.32x^2$	10.56	71.8	NS
-	CHA x NZWDBD	$Y = -579.96 + 45.88x$	4.27	85.3	* * *
-	CHA x NZWDBD	$Y_1 = -2633.68e + 991.75x$	93.03	85.0	* * *
-	CHA x NZWDBD	$Y_2 = -380.14 + 27.41x + 0.42x^2$	2.40	85.3	NS
-	CHA x NZWCRL	$Y = 294.82 + 6.41x$	8.79	4.6	NS
-	CHA x NZWCRL	$Y_1 = 4.60e + 139.57x$	190.17	4.7	NS
-	CHA x NZWCRL	$Y_2 = -677.41 + 96.34x - 2.08x^2$	10.26	5.0	NS
-	NZWCRL x NZWCRL	$Y = -405.61 + 42.29x$	38.34	63.5	* * *
-	NZWCRL x NZWCRL	$Y_1 = -2443.94e + 960.95x$	202.74	65.2	* * *
-	NZWCRL x NZWCRL	$Y_2 = -4291.86+ 388.74x - 7.69x^2$	4.53	71.1	NS

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the importance of another criterion in judging different models that is the predictive ability.

Thus, one of the objectives in establishing a mathematical model of production trait is to predict whole record production frompastrecords.Prediction isnecessary for economic projection.Mathematical models providemeans of prediction, but they are sometimesnadequate due to poor extrapolative properties or large deviationsrom expectations[20] .In the present study, the predictive aspect of the models was to be an important consideration for ranking the utilities of the three models used. Thepredictions play important roles in early selection,production planning and economical decision-making [30] On this basis, the exponential was less suitable than the linear and the quadratic functions.Using differentfunctions, several workers[20,26,28,30,31] observed that all models did not fit all data equally well. McMillan, et al; [29]found out that all the models they examined predicted whole-record egg production of two selected strains better than that of an unselectedcontrol strain, and the rank of the two predictive models changed with strain.

CONCLUSION

The study demonstrated either a positive or negativerelationships between live body weight and bodymeasurement components (NTS, STL, HGT, HWT, LTE TKL) of the genotypes at 35 and 56 days of age. The relationships indicated that increase in the growth rate of any of the components would correspondinglyincrease live weight gain. The simple linear and non-linear regression analyses showed that based on R^2 values, polynomial functions was superior in terms ofgoodness of fit to the data and its ability to predict, followed by linear and exponential functions. It wasobserved in this study that all models did not fit all dataequally well.

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